Oral presentation

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Overview of global monitoring of terrestrial chlorophyll fluorescence from space

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Despite the critical importance of photosynthesis for the Earth system, understanding how it is influenced by factors such as climate variability, disturbance history, and water or nutrient availability remains a challenge because of the complex interactions and the lack of GPP measurements at various temporal and spatial scales.

Space observations of the sun-induced chlorophyll fluorescence (SIF) electromagnetic signal emitted by plants in the 650-850nm spectral range hold the promise of providing a new view of vegetation photosynthesis on a global basis. Global retrievals of SIF from space have recently been achieved from a number of spaceborne spectrometers originally intended for atmospheric research. Despite not having been designed for land applications, such instruments have turned out to provide the necessary spectral and radiometric sensitivity for SIF retrieval from space.

The first global measurements of SIF were achieved in 2011 from spectra acquired by the Japanese GOSAT mission launched in 2009. The retrieval takes advantage of the high spectral resolution provided by GOSAT's Fourier Transform Spectrometer (FTS) which allows the evaluation of the in-filling of solar Fraunhofer lines by SIF. Unfortunately, GOSAT only provides a sparse spatial sampling with individual soundings separated by several hundred kilometers. Complementary, the Global Ozone Monitoring Experiment-2 (GOME-2) instruments onboard MetOp-A and MetOp-B enable SIF retrievals since 2007 with a continuous and global spatial coverage. GOME-2 measures in the red and near-infrared (NIR) spectral regions with a spectral resolution of 0.5 nm and a pixel size of up to 40x40 km2. Most recently, another global and spatially continuous data set of SIF retrievals at 740 nm spanning the 2003-2012 time frame has been produced from ENVISAT/SCIAMACHY. This observational scenario has been completed by the first fluorescence data from the NASA-JPL OCO-2 mission (launched in July 2014) and the upcoming Copernicus' Sentinel 5-Precursor to be launched in early 2016. OCO-2 and TROPOMI offer the possibility of monitoring SIF globally with a 100-fold improvement in spatial and temporal resolution with respect to the current measurements from the GOSAT, GOME-2 and SCIAMACHY missions.

In this contribution, we will provide an overview of existing global SIF data sets derived from space-based atmospheric spectrometers and will demonstrate the potential of such data to improve our knowledge of vegetation photosynthesis and gross primary production at the synoptic scale. We will show examples of ongoing research exploiting SIF data for an improved monitoring of photosynthetic activity in different ecosystems, including large crop belts worldwide, the Amazon rainforest and boreal evergreen forests.